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THE AGRONOMIST'S PART IN THE WORLD'S FOOD SUPPLY[1]

THE welfare of mankind is intimately bound up with the world's food supply. Not that man can "live by bread alone," but he is unable to devote himself to the higher phases of an advancing civilization if he is conscious of the gnawings of hunger. Since the shortage in various food products during the war, people generally have taken a much keener interest in the whole question of food supply. The old statement that "we never miss the water till the well runs dry" is here exemplified. So long as the grocer had plenty of flour and sugar most people considered the supply in much the same way as they considered the supply of air. The only worry was to find money with which to purchase needed articles.

When it became necessary to go to a dozen stores before being able to buy any sugar, and then only a pound or two; when the meat allowance was restricted; and when white flour had to be supplemented by all kinds of substitutes—then people began to realize that the supply of food might not be inexhaustible.

The shortage of food during the war has been a good lesson for the people of the United States. It has taught them what some of the peoples of Asia have been so often forced by famine to realize, namely, that food can be had only when a supply is available, and that this supply may at times be far short of actual needs. Conditions during the war were of course unusual; we hope they will never recur. I do not at this time desire to consider the food shortage due to the war but rather the whole food situation as it is likely to affect mankind in the future as the

[1] Address of the president of the American Society of Agronomy, Springfield, Mass., October 18, 1920.

population of the earth increases. There will be of course temporary local short-time food shortages due to unfavorable seasons, wars, or other unusual conditions. These situations will have to be met as best they can at the time. The thing to which I should like to direct attention at present is not this temporary condition of famine but rather the means by which people may be fed when the world becomes much more populous than it now is. Having an earth, the best land of which is already producing crops without any great surplus, how is it going to be possible for nations to grow, cities to be built, and civilization to advance? Is there a limit to the number of people for whom the earth can supply food, or can the increase go on indefinitely?

As a small boy I remember going through what seemed to me to be an immense forest with a man who said it contained enough timber to last the whole United States for a thousand years. In later years when I became old enough to make the calculation, I found that this particular body of timber would not furnish America's needs for a single year.

In the early days of the settlement of the west many who saw the large rivers made the statement that the water of these rivers could never be exhausted by irrigation. The supply was said to be limitless. Experience has shown that the water of many of these streams was exhausted before more than a fraction of the adjacent land could be served. Thus, all things have their limits. There is a limit to the number of people a given area of land can sustain, and since the area of land is practically constant there must be a limit to the number of people that can be fed. The number of course depends entirely on how fully the resources of the earth are utilized. It is possible greatly to increase production. I wish particularly to call attention to the methods by which the agronomist may assist in accomplishing this end.

I am not an alarmist. I do not wish to appear as one who is trying to stir people up unnecessarily. I should not even like to take the responsibility assumed by Sir William Crookes, who, in his presidential address before the British Association for the Advancement of Science in 1898, set a date when the shortage of food would begin to be felt. I do not believe that there is sufficient data available for any one to be so definite. A few facts, however, may be used to help in clarifying our minds on the subject.

It is well known that the population of all important countries of the world is gradually increasing. During the 110 years from 1800 to 1910 the population of the world increased from 640,000,000 to 1,600,000,000, or an increase of 152 per cent. Only a few generations ago there were vast continents of unsettled fertile land waiting to absorb the overflow from the populous parts of the world. There are still many large tracts of land that are not settled, but it is obvious to all who have made a study of the subject that the better lands are rapidly being put under cultivation, and only the more remote and more unfavorable areas remain. This does not say that there is not still available much excellent land, but let us consider the United States as an example.

In 1790 the population of the entire country was 3,929,214; by 1840 it had reached 17,059,453; while the 1920 census shows it to be more than 105,000,000. A century ago only the east coast was settled; the great heart of the agricultural land had not been touched. The rapidity of settlement of the middle northwest is indicated by the fact that between 1800 and 1820 the population of Ohio, Indiana, Illinois, Michigan, Wisconsin and Iowa was increased from 50,240 to 792,719, and by 1840 it had reached 2,967,840. Today the entire country has been thoroughly explored and the better land has been producing for nearly a generation.

In order to see just how our production and consumption have balanced during the last three score and ten years—the allotted time of man—let us examine the figures for wheat, probably our best index crop.

WHEAT PRODUCTION AND EXPORT IN UNITED STATES AVERAGE BY 10-YEAR PERIODS, 1849–1919

Decades	Bushels Produced per Year (Average)	Bushels Exported per Year	Per Cent. Exported
1849	100,486,000	7,535,901	7.5
59–68[1]	190,395,750	21,475,072	11.3
69–78	285,951,600	73,634,732	25.7
79–88	446,587,600	133,703,079	29.9
89–98	495,184,800	165,377,944	33.3
99–1908 ..	651,643,800	152,533,604	23.4
1909–18.....	754,471,400	172,400,807	22.8

In 1849 we produced approximately one hundred million bushels of wheat in the country, only 7.5 per cent. of which was exported. With the rapid settlement of the west production rose till during the decade 1879–1888 it reached 446,587,600 bushels, 33.3 per cent. of which was exported. Thus new productive land was brought under cultivation much faster proportionately than population increased. After this time, however, the population so gained on production that during the next decade only 23.4 per cent. of the wheat produced was exported, and during the ten years from 1909–1918 the exports averaged 22.8 per cent. of the production. This figure was much increased by extra exports during the war. During the years immediately preceding the war the exportation of wheat had almost ceased. In 1880, 80.4 per cent. of our exports consisted of agricultural products, where as in 1910 the percentage had dropped to 50.9.

These figures are significant since they show that, even in a country like the United States where the area and the resources seem to be almost limitless, it will not be long possible to continue to feed other than our own increasing population.

A condition that helps to bring this about is the rapidly increasing proportion of our city dwelling population. In 1820 only 4.93 per cent. were urban. In 1880 it had reached 29.5 per cent. leaving still 70.5 per cent. rural; ten years later 36.1 per cent. were urban and 63.9 per cent. rural; in 1900 only 40.5 per cent. were urban; and by 1910, 46.3 per cent. were urban and only 53.7 per cent. rural. Indications from the 1920 census are that this year will show more people living in cities than in the rural districts.

[2] Average of only 4 years.

With a condition of this kind the food situation is likely to become more acute than where most of the population live on the farm where they can more quickly influence the rate of food production. With the growth of many large cities and with the complex systems of modern transportation and exchange, the food question tends more and more to become a single whole-world problem rather than numerous small local problems affecting the smaller communities. With our modern systems unobstructed by war we shall probably never again have such devastating local famines as were so common in past generations in India, China, and Russia during years when there was an abundance in other parts of the world.

The situation as it appears to me is this: We live in a world with an increasing population. This increase can not expand indefinitely to fertile unoccupied lands since these lands are becoming scarce. The food supply must be increased as fast as the population increases, since food supply is the chief limiting factor in population growth.

There is no immediate cause for alarm, but it is the duty of scientists and statesmen to look to the future. We must not be content to be like Sam the negro who took his stove to his boss and offered it for sale for a fraction of its value. On being asked if he would not need it next winter he said he would but that winter was three months away while the circus was to-morrow.

Satisfying the needs of to-day is not sufficient: we must maintain a forward-looking attitude. It is impossible to make large increases in production quickly; years of preparation and work will be required to do anything of permanent value. An adequate solution of the world's food problem can be made only by deliberate planning. All factors involved must be considered and a world-wide program of work initiated, for the world is not a unit in production and in consumption.

The problem will involve a great variety of business and scientific interests. Credit, transportation, manufacturing and mechanics must all be called on to do their part. What we are now most interested in, however, is the contribution of the agronomist. What is his part in the world's food problem?

An examination of the question indicates that his part is a large one. While it is not entirely clear just what is included under the word "agronomy," the general understanding is that it has to do with anything affecting crop production, and since the food supply is in the last analysis a question of crop production, it would appear that the agronomist has a great responsibility in seeing that the people of the world do not want for something to eat.

Let us see what means he has available to meet this responsibility. We have already shown that the increasing population will call for increased production. This increase can be met in just two ways: First, by extending the producing area, and secondly, by increasing the acre-yield of the present cultivated area.

The method of enlarging the agricultural area will be discussed under the following four headings: (1) Increasing the irrigated area, (2) extending dry-farming, (3) drainage of wet lands, and (4) reclamation of alkali lands.

Of course there are uncultivated lands in the world that will not require any of the methods of reclamation mentioned above to make them productive. They may be inaccessible, or for some economic reason it may not pay to cultivate them even though they are fertile. In cases of this kind the agronomist has no particular responsibility. He is concerned primarily in solving the problems which call for his particular training in science. Since the better lands are already in use most of the increased area will be made available largely by cultivating the less favorable lands.

The methods by which we shall increase the yield on lands that are under cultivation will be discussed under the following three headings: (1) Increasing the fertility of the soil, (2) better tillage methods, and (3) the improvement of crops by breeding.

More than half the surface of the earth receives insufficient precipitation for the most favorable growth of crops. The best method of making up this deficiency is through the application of water by irrigation. Unfortunately, the supply of water for this purpose is so limited that only a fraction of the land can be served. In many cases hundreds of thousands of acres of fertile land are found adjacent to a stream that does not contain enough water for a tenth of the land. In a case of this kind it is obvious that the volume of water and not the land area is the factor limiting production.

Here the agronomist's problem lies in the direction of making the limited water produce as much as possible for each acre-foot. He must call in the engineer to help in storing the water of the flood season and making it available when it can be used by crops.

During the early days of irrigation no attempt at storage was made, but as the demand for water increased reservoirs were constructed, often at great cost. With the present structures, probably not more than half of the water in streams of the arid sections is fully used. The remainder runs to waste during the high water or is lost through inadequate systems. One of the first steps that may be taken to increase food production is the construction of additional storage reservoirs and the improvement of canals to eliminate seepage losses.

Even the water that is delivered to the land falls far short of reaching its maximum duty. Many questions affecting the water economy of crops must still be investigated and there must be a wider application of principles of scientific irrigation before the available water will produce maximum crops. The periods when crops are most sensitive to water applications, the varying needs of different crops, the best methods of applying water to each type of soil, and numerous other similar questions must be investigated by the agronomist

and taken fully into account before the arid regions can develop to their full fruition.

It is difficult to give exact figures, but it seems probable that when all possible economies are put into operation the irrigated area of the United States can be enlarged to about four times the present area. It is largely through the agronomist, assisted by the irrigation engineer, that this enlargement can be brought about.

After all possible sources of irrigation water are fully utilized there will be many millions of acres of arid land that can not be served. The only possible chance for producing crops on this land is through the methods of dry-farming, which means that every process is directed toward moisture conservation.

Dry-farming is essentially a branch of agronomy. It is based on a system of tillage that will store in the soil the moisture of one or two years till it is needed by crops. Its success depends on the selection of crops that can endure the rigors of drouth and the breeding of special drouth-resistant varieties.

Probably a larger area can be added to the present productive land by the conquest of drouth than by any other means, but drouth is a relentless enemy of crop production and its successful conquest will call for all the ingenuity of students of soils and crops. Part of the preliminary work has already been done, so that one now sees grain fields where only sagebrush was found a few years ago; but there still remain many difficulties to be overcome before all these vast areas can be made to serve the needs of man.

In humid sections great tracts of land are covered with swamps and produce no important human food. When reclaimed these lands are often exceedingly fertile. The drainage of some of the larger swamps offers rather serious engineering difficulties, but these can in most cases be overcome. The drained swamp with its peaty residue calls for special methods of management and fertilizing, but since agronomists are seeking problems to solve they will not be discouraged by the difficulties encountered in changing a drained swamp into a fertile field.

Somewhat related to the drainage of the swamp comes the reclamation of alkali land since it is largely through drainage that alkali is overcome.

In all arid parts of the world the soil is likely to contain such an excess of soluble salts that crops can not be raised. This condition becomes more acute under irrigation. At the present time in the United States there are millions of acres of land that fail to produce good crops chiefly because they are impregnated with salts. In some of the western states alkali is considered to offer one of the most important and difficult problems affecting agriculture. It will be met by drainage, by special soil treatment, by breeding more resistant crops, and in other ways that agronomists may devise. The problem is now waiting; its solution will mean more food for the world.

Since 1840 when Liebig explained how crops feed great progress has been made in increasing the productivity of the soil. Before the rôle of mineral matter in the growth of plants was understood, all sorts of theories were advanced concerning the food used by plants and as a result many inconsistent practises of fertilizing the soil grew up.

When the real basis of plant nutrition was determined, the beginning of a rational use of fertilizers was at hand. This has resulted in increasing very materially the crop-yields of many soils.

Just how much the acre-yield can be increased is uncertain, but we are sure that by the proper use of fertilizers, by rotation and by better tillage methods the present cultivated area may be made to produce very much more than it is now producing, but the acre-yield can not be increased indefinitely.

Last year in his presidential address before this society, Dr. Lipman ably discussed the nitrogen problem in its relation to increased food production. Each element entering into commercial fertilizers might have been discussed by him with equal interest, so many are the problems surrounding the supplying

of food to plants. Agronomists may be sure that they have not yet found out every method of increasing soil fertility by the use of fertilizers. As the needs for food become more pressing many additional discoveries will result from the researches of students of the soil.

Superior tillage methods, better rotations, and many other improvements in soil management may be expected to contribute to the increasing of the yield of the present cultivated area.

So much has been done during the last few generations to improve crops that we should hesitate before placing any limit on what may be accomplished in this respect in the future. The discovery of some of the fundamental principles of heredity has made progress much more rapid during the last few years than previously when everything was done by the hit-or-miss method.

If no additional land could be added to the cultivated area and if there were no way to increase the fertility of the soil, considerable relief in the food situation might in time be expected to come from crop improvement alone; but when this can be taken in connection with the others, it becomes an especially valuable tool. For example, there are almost unlimited possibilities in developing crops suited to resisting drouth, soil alkali, or other unfavorable conditions in which ordinary crops can not thrive. But here too there is a limit to possible improvements.

From the foregoing, it is evident that the agronomist will be able to render valuable service in insuring an adequate food supply for the increasing population of the world. The question now arises as to what his duty is in the matter. Should he sit idly by as a disinterested spectator and allow things to take their natural course, or should he assume initiative and take an active part in helping to forestall trouble? Will he be one who will give the ounce of prevention, or will he wait till the pound of cure is required? Probably both courses will be taken.

He who is progressive, he who takes his work seriously and is anxious to use his training for the welfare of his fellows, will doubtless take the more positive attitude and devote himself energetically to the solution of the many problems that crowd upon him. Only by profound research can these problems be solved; but he who devotes himself honestly to seeking these solutions will find joy unspeakable and will render a lasting service to mankind.

F. S. Harris
Agricultural Experiment Station,
Logan, Utah

SCIENTIFIC AND INDUSTRIAL RESEARCH IN FRANCE, ITALY, BELGIUM AND JAPAN

The British Committee of the Privy Council for Industrial and Scientific Research in their annual report to Parliament give some account of similar work in other countries. In addition to the activities of the French Department of Scientific, Industrial and Agricultural Research and Inventions, attached to the Ministry of Public Instruction, important steps towards building a great optical industry in France have been taken by the French Ministry of Public Instruction and Commerce, under whose auspices there has been created in Paris an establishment known as L'Institut d'Optique Théorique et Appliquée, with General Bourgeois as president. The institution will include a school of advanced optics, a research and testing laboratory, and a professional school. Measures have been taken to secure a government subvention and an appeal for funds has also been addressed to scientific and industrial organizations. Progress has also been made in engineering research in France. The metallurgical and engineering firms in Grenoble are showing a commendable exhibition of independent initiative and, without waiting for a more or less problematical government grant, have collected funds to found a mechanical and metallurgical laboratory. The laboratory itself is secured and they have appointed a competent local man as its head. There only remains the acquisition of the needful machinery and equipment. This is to be obtained partly by purchase and partly by gifts.

The Italian government has decided to devote special attention to the establishment of industrial experimental stations and the encouragement of technical education. Besides studying new processes and making new applications of old methods, these stations will supply industries with a trained personnel. Five such stations have already been established—two at Milan, for paper and fats respectively; two at Naples, for leather and ceramics; and one at Reggio Calabria, for essential oils and perfumes. It is planned to establish three new stations: one at Rovigno, for the sugar industry; another at Milan, for the development of the refrigerator industry; and a third, probably at Rome, to study the distillation of gases and their by-products and, in general, all processes of combustion. Other stations are under consideration. Laboratory schools are being organized at Turin, Milan, Genoa, Florence, Rome, Naples and Palermo. Provision is also being made for ordinary schools of industry, of which 150 will be royal schools and 400 others subsidized.

The establishment of a national system for encouraging scientific and industrial research in Belgium has been provisionally approved by the minister, but details have not yet been published.

An Institute of Physical and Chemical Research was established in Japan in 1917 with government support of £200,000 over a period of ten years, while a gift of £100,000 has been received from the emperor. The balance of the £800,000, which is required is being collected from private sources. The institution is apparently intended to serve three purposes: (*a*) the prosecution of fundamental researches; (*b*) the conduct of industrial investigations on lines similar to those of the Mellon Institute; and (*c*) the training of research workers who will be elected from among university graduates to research scholarships. Until the laboratories of the institute can be built in Tokyo accommodation is being provided by the universities of Tokyo, Kyoto and Sendai. It is understood further that another Imperial Ordinance has been issued announcing the establishment of a new Bureau in the Department of Agriculture and Commerce for the purposes of industrial experiment. This bureau will control work in connection with experiments, analysis, appraisal and instruction. There will be two experimental stations; one in the Tokyo district and one in the Osaka district.

SCIENTIFIC EVENTS

AERONAUTIC SECTION OF THE AMEERICAN SOCIETY OF ENGINEERS

IN the field of aviation a good deal of cooperative engineering work has been done, standards have been established, details of construction perfected, interchangeability secured. Nevertheless there still exists the real opportunity for promoting in a large way the broad engineering development having to do with the future of aerial navigation regarded as an essentially international science, art and business. To this end the members of The American Society of Mechanical Engineers interested in aeronautics have organized themselves into a professional section of this subject.

Howard E. Coffin, Jesse G. Vincent, Orville Wright, C. F. Kettering, Elmer A. Sperry, James Hartness, John R. Cautley, Lionel S. Marks, Miller R. Hutchison, Charles E. Lucke and Joseph A. Steinmetz, all prominent in the aeronautic field in the war, are among those who have registered in the section.

As chairman of the advisory committee on aeronautics under the Council of National Defense, Mr. Coffin sent the first American delegation to the London Conference on Aircraft in the spring of 1918. In the full realization of the possibilities of future commercial as well as military and naval development, the Peace Conference created a commission for drafting an International Aircraft Convention. Benedict Crowell, assistant secretary of war, and as chairman of the American Aviation Mission visiting Europe in 1919, urged the adoption of a definite engineering basis to secure the future of air navigation and to guide bodies entrusted with the formulation of laws. Herbert Hoover, in his recent address before the American Institute

of Mining Engineers, stressed the limitations of individual initiative and development, and the crying need for definite, comprehensive programs for the solution of our great engineering problems. These things have influenced the A. S. M. E. to take the step of organizing this section with the hope that, through cooperation with all the agencies interested in and working in this field, general good will be brought to the whole industry.

COMMITTEE ON PROBLEMS OF ELECTRICAL INSULATION

The National Research Council has planned an investigation of the principles of insulation, a matter which is of vital importance to the electrical trade and to its consumers. A meeting of the council's insulation committee was held recently at the laboratories of the Western Electric Company at 463 West Street, New York City. It was attended by a number of engineers and physicists, the chief engineer of the Western Electric Company, Dr. F. B. Jewett, who is chairman of the committee, presiding.

A preliminary meeting of the committee was held a year ago, but at that time no definite plans were formulated. At this meeting it was decided that the first step is the gathering together of all the published and known scientific material relating to insulation. This is a large undertaking and the committee decided that a permanent salaried secretary should be engaged to carry on the compilation of the material which has already been published and to maintain continuity in the records and activities of the committee. The committee also decided that it would attack the technical problems by providing some research men in the universities with funds and materials supplied by the industries under the guidance of the National Research Council. The scarcity of skilled and trained research men, who are capable of attacking insulation problems is a matter of much concern to the insulation committee. An effort will be made to discover among the post-graduate students and the faculties of the universities men who are able to do this work.

The committee consists of thirty-seven representatives from the electrical industries, the national engineering societies, the national scientific societies, the national manufacturing organizations and the universities and colleges of the country. Among those who attended the meeting were: Mr. C. E. Skinner, Westinghouse Electric & Manufacturing Co., Dr. Irving Langmuir, General Electric Co., Mr. Percy H. Thomas, Consulting Electrical Engineer, New York, Mr. William A. Del Mar, New York, D. W. Roper, Commonwealth Edison Co., Chicago, Ill., Dr. Clayton H. Sharp, Electrical Testing Laboratories, New York, Professor John Johnston, Yale University, Professor Frederick Bedell, Cornell University, Professor A. E. Kennelly, Massachusetts Institute of Technology, Professor K. T. Compton, Princeton University, Edward D. Adams, Engineering Foundation, New York, Dr. Carl Hering, consulting engineer, Philadelphia, Pa., John M. Weiss, The Barrett Company, New York, Dr. Richard C. Tolman, Chemical Division, National Research Council, Washington, D. C., and Dr. F. B. Silsbee, Bureau of Standards, Washington, D. C.

THE ORIENTAL INSTITUTE OF THE UNIVERSITY OF CHICAGO

Director James Henry Breasted, of the Oriental Institute of the University of Chicago, who recently returned from an archeological survey of the Near East, reports that the remarkable collections which the expedition was able to purchase have arrived at the Haskell Oriental Museum and are now unpacked preparatory to their public exhibition.

Among these is a complete group of twenty-five painted limestone mortuary statuettes from Egypt, representing the deceased and the members of his family engaged in all sorts of household activities. They date from the Old Kingdom (3,000 to 2,500 B.C.) and form the most extensive group of such figures ever discovered in one tomb. In addition to a group of royal seal cylinders and a group of some

seventy-five alabaster vases, is a collection of about a hundred and fifty predynastic and early dynastic hard stone vases, one being inscribed with the name of the first Pharaoh (3,400 B.C.).

Among other acquisitions is a group of about one hundred bronzes, including some sixty-five statuettes and a series of fine battle-axes which form the finest collection of bronzes ever brought from the Near East to America. A beautifully written papyrus roll of the Book of the Dead, probably of the seventh or sixth century B.C., is far the best manuscript of this book as yet brought to America; and the purchase of the Timins Collection of stone weapons and implements gives to the university the finest collection of Egyptian Stone Age industries in this country.

From Asia comes a series of two hundred and fifty-eight cuneiform tablets containing business records and a copy of the Royal Annals of Sennacherib. The latter document is in the form of a six-sided prism of buff-colored terra cotta in perfect preservation. It records the great campaigns of the famous Assyrian emperor, including the western expedition against Jerusalem in which he lost a large part of his army. No such monument as this has yet been acquired by American museums, and it will be of primary value to students and of unique interest to the public. Of other cuneiform documents the purchases total a thousand tablets, some of special literary and religious interest.

THE NEWS SERVICE OF THE AMERICAN CHEMICAL SOCIETY

IN his report the technical director of the A. C. S. News Service says:

The reports from the clipping agencies indicate that the publicity given to the Chicago meeting was exceptionally large. Whether it will equal in volume or surpass that received from the St. Louis meeting can not be ascertained until the full returns are analyzed.

As Chicago is one of the world's greatest news distributing centers, the wires of the Associated Press, the United Press and similar organizations sent out many dispatches to the newspapers of the country, as is shown by the sheaves of clippings now being garnered by the A. C. S. News Service. The admirable dispatch summarizing the work of the meeting, written by Mr. Richard D. Jones, of the United Press, had an especially wide distribution. The daily papers throughout Illinois, Indiana and various parts of the middle west carried unusually full accounts.

The sixtieth meeting was held in the midst of a political campaign and in a city, the press of which happened to be giving more than usual attention to local affairs. The Chicago newspapers, however, printed about ten columns concerning the sessions. The most attention was given by the *Journal*, and the other leading Chicago papers are herewith given according to the space allotted by each: *Tribune, American, Daily News, Post, Herald-Examiner.*

Extensive dispatches were printed in the eastern papers and some of them appeared in prominent positions. The subjects which seem the most popular to date, as far as lay journalism is concerned, are flavoring extracts without alcohol, the resolution urging Congress to pass dye legislation, hydrolyzed sawdust as cattle food, all news relating to fuel and news print, and the announcement that America now makes 800 rare chemicals, this last being featured on the front page of the *New York Times.*

More trade and technical publications sent representatives than ever before in the history of the Society, because of the fact that so many periodicals of this class are either published in Chicago or have branch offices there.

The A. C. S. News Service wishes to acknowledge the very efficient help of the Chicago Section's Publicity Committee, of which Mr. Chester H. Jones is the chairman.

GRANTS FOR RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE attention of investigators is called to the fact that the committee on grants of the association will soon have at its disposal some four thousand dollars for distribution in aid of research. Amounts up to about five hundred dollars will thus be available for work in each of the various sciences: mathematics, physics, chemistry, astronomy, geology, zoology, botany, anthropology, psychology, social and economic sciences, and education. The rules governing the assignment of grants were published in SCIENCE for January 23, 1920.

Applications for grants should be made not later than December 1, 1920, to any member of the committee, the personnel of which is as follows: Henry Crew, chairman; W. B. Cannon, R. T. Chamberlin, G. N. Lewis, George T. Moore, G. H. Parker, Joel Stebbins and Robert M. Yerkes. The awards will be announced soon after January 1, 1921.

Joel Stebbins,
Secretary Committee on Grants
Urbana, Ill.

SCIENTIFIC NOTES AND NEWS

The International Congress of Mathematicians at the Strasbourg meeting accepted the invitation presented by Professor Leonard E. Dickson to hold the next congress in New York in 1924.

At the International Congress of Physiologists, held in Paris, it was resolved, on the invitation of Sir E. Sharpey Schafer, to hold the next meeting in Edinburgh in 1923.

Professor Stephen Moulton Babcock, of the University of Wisconsin, inventor of the Babcock test for determining the amount of butter fat in milk, reached his seventy-seventh birthday on October 22, and in honor of the event and of his work a university convocation was held. Professor Babcock is engaged in active work in his laboratory.

Dr. Emile Roux, director of the Pasteur Institute, Paris, has been awarded the Grand Cross of the Legion of Honor, with the citation: "Principal collaborator and disciple of Pasteur, throughout an admirable life of simplicity, modesty, labor and devotion he has continued the great work of his master, notably by his researches on diphtheria; by his discovery of antidiphtheritic serum he has conquered this formidable disease and has saved a great number of lives. President of the Conseil supérieur d'hygiène, director of the Pasteur Institute for which he has gained universal renown. A noble and great figure in the world of science."

The Rumford Committee of the American Academy of Arts and Sciences has made the following appropriations in aid of research: To Profesor W. W. Campbell, of Lick Observatory, $360 for the purchase of a special photographic lens; to Professor H. L. Howes, of the New Hampshire State College, $90 in aid of his researches on luminescence.

Dr. F. Hastings Smyth, formerly captain in the Chemical Warfare Service, has joined the staff of the Geophysical Laboratory, Carnegie Institution of Washington.

Mr. L. E. Jackson has resigned as chemist and chemical engineer with the Empire Gas & Fuel Co., Bartlesville, Okla., to accept a fellowship at the Mellon Institute.

Professor Mark Alfred Carleton, formerly cerealist of the United States Department of Agriculture, and recently plant pathologist of the United States Grain Corporation, is at present engaged as plant pathologist for the United Fruit Company, with headquarters at Bocas del Toro, Panama. At the last meeting of the American Society of Agronomy Professor Carleton was elected the first honorary life member of that society.

Dr. L. O. Grondahl, until recently associate professor of physics at Carnegie Institute of Technology, Pittsburgh, Pa., has resigned to accept the position of director of research with the Union Switch and Signal Company, Swissvale, Pa.

D. Harrison E. Patten, for several years research chemist with the Bureau of Chemistry of the Department of Agriculture, Washington, D. C., has accepted the position of chief chemist of the phosphate plant of the Provident Chemical Works, St. Louis, Mo.

Dr. Frederick E. Breithut has entered the employ of the Calco Chemical Company, Boundbrook, New Jersey.

George P. Gray has resigned his position as assistant professor of entomology and chemist, insecticide laboratory, at the University of California, to become chief of the Division of Chemistry of the newly established Department of Agriculture of the State of California, Sacramento, Calif.

Mr. Samuel H. Simpson has resigned his position in the physical chemistry section of

the Bureau of Standards, Washington, D. C., and is now in the sales division of the Edison Electric Appliance Co., Chicago, Ill.

SAMUEL J. PLIMPTON has returned from a year's leave of absence in Europe and has taken up his work as professor of physics at Worcester Polytechnic Institute.

MR. W. P. WOODRING and a party from the U. S. Geological Survey have left for Haiti to conduct a reconnaissance geologic examination of the Republic of Haiti at the request of that government.

DR. AND MRS. CASEY A. WOOD, of Chicago, have gone to British Guiana for the winter. Dr. Wood plans to conduct some researches on the comparative anatomy of the eye with special reference to birds.

CLIFFORD S. LEONARD, who received the degree of Ph.D. from the University of Wisconsin in June, has accepted one of the traveling fellowships of the American Scandinavian Foundation, and has sailed for Sweden. He will study chemistry and pharmacology at the Karolin Institute in Stockholm.

AT the 149th meeting of the Washington Academy of Sciences on October 23, Dr. E. B. Rosa, chief physicist of the Bureau of Standards, gave an address on "A reorganized civil service." Those expected to take part in the discussion were Colonel W. B. Greeley, chief forester, Department of Agriculture and president of the Federal Club; Mr. Paul F. Myers, deputy commissioner of internal revenue; Dr. George Otis Smith, director of the Geological Survey; Dr. F. G. Cottrell, director of the Bureau of Mines; Dr. P. P. Claxton, commissioner of education; Mr. O. C. Merrill, executive secretary, Federal Power Commission; Mr. Martin A. Morrison, president, Civil Service Commission; Mr. Lewis Meriam, assistant director, Institute for Government Research.

THE meeting of the New York Section of the American Chemical Society on October 22 was in the nature of a welcome to Dr. W. A. Noyes, professor of chemistry in the University of Illinois. The following addresses were made: "The foundation for chemical development," by Professor W. A. Noyes, and "The National Research Council and chemical development," by Harrison E. Howe.

DR. COLIN G. FINK, of New York, recently addressed the Rochester Section of the American Chemical Society on "Modern developments in metallurgical research."

THE inaugural lecture of Professor Maximilian Toch, recently appointed adjunct professor of industrial chemistry at Cooper Union, was given on October on the subject "The chemistry of artistic painting."

PROFESSOR JULES BORDET, director of the Pasteur Institute of Brussels, delivered the second Harvey Society lecture at the New York Academy of Medicine on October 30. His subject was "Coagulation of the blood."

ON the evening of November 12 a service in memory of the late Dr. Eric Doolittle, professor of astronomy, will be held in the auditorium of Houston Hall, University of Pennsylvania. Addresses will be made by Professor Frank Schlesinger, of the Yale Observatory, and president of the American Astronomical Society, the Rev. Robert Norwood and Provost Edgar F. Smith.

ALFRED E. FLETCHER, known for his work in industrial chemistry and especially in the English alkali industry, has died at the age of ninety-four years.

A SITE for the new building in Washington which is to serve as a home for the National Academy of Sciences and the National Research Council has recently been obtained. It comprises the entire block bounded by B and C Streets and Twenty-first and Twenty-second Streets. Northwest, and faces the Lincoln Memorial in Potomac Park. The academy and council have been enabled to secure this site, costing about $200,000, through the generosity of the following friends and supporters: Thomas D. Jones, Harold F. McCormick, Julius Rosenwald, and Charles H. Swift, Chicago; Charles F. Brush, George W. Crile, John L. Severance and Ambrose Swasey, Cleveland; Edward Dean Adams, Mrs. E. H. Harriman, and the Com-

monwealth Fund, New York City; George Eastman and Adolph Lomb, Rochester; E. A. Deeds and Charles F. Kettering, Dayton; Henry Ford, Detroit; Arthur H. Fleming, Pasadena; A. W. Mellon, Pittsburgh; Pierre S. duPont, Wilmington; Raphael Pumpelly, Newport; Mr. and Mrs. H. E. Huntington, Los Angeles; Corning Glass Works Corning, New York. Funds for the erection of the building have been provided by the Carnegie Corporation of New York.

The American Chemical Society has increased the annual dues from ten to fifteen dollars. The finance committee reports that for the present year the society will just about keep inside its budget as a whole, excepting for the matter of printing. In the item of printing, all the journals are necessarily running beyond their budgets due to the increases in costs of paper and printing that have already accrued. If the journals print the same amount of material for the next four months that they have been averaging, and the cost of paper, printing, etc., are the same as it has been for the last eight months, then the *Journal of the American Chemical Society* will exceed its budget by nearly $10,000; *Chemical Abstracts* will exceed its budget by nearly $8,000; and the *Journal of Industrial Chemistry* will exceed its budget by nearly $3,000.

The Paris correspondent of the *Journal* of the American Medical Association writes that the president of France having decreed that the public welfare demands the creation of certain institutes, notably an institute of hygiene, in affiliation with the University of Paris, on grounds accruing from liquidation of the congregation of Jesuits, the minister of public instruction has been authorized to acquire this property by expropriation in the name of the state.

The London *Times* reports that in a discussion on the Einstein theory of relativity at Bad Nauheim on September 23 Professor Grebe, of Bonn, declared that the third test had been passed. According to Professor Einstein, there should be a "shift" towards the red of the lines in the solar spectrum of from 0.62 to 0.63. The absorption bands of nitrogen had been selected and compared with a spectrum of a carbon arc. More than 20 measurements of each line had been made. There were differences in the "shift" of individual lines, but when allowance had been made for disturbing factors the "shift" was found to be about 0.66—a close agreement with prediction.

For many years Dr. Joseph Lane Hancock, of Chicago, has been recognized as an authority on the Tettiginæ or Grouse-locusts, and in that time has assembled probably the largest collection of these insects extant, numbering over five thousand specimens. Due to added medical responsibilities, Dr. Hancock has now closed his Orthopterological studies and his collection has been added to the Hebard Collection of Orthoptera at the Academy of Natural Sciences of Philadelphia. In order to continue the work in this group, Dr. Hancock's correspondents and collectors are invited to communicate with Mr. Morgan Hebard, Academy of Natural Sciences, 1900 Race St., Philadelphia, Pa. Every effort will be made to continue the growth of the collection of Tettiginæ as well as carrying on the systematic studies.

We learn from the *British Medical Journal* that last spring a beginning was made at University College, London, with the foundation of a school of the history of science. Dr. A. Wolf, reader in logic, then made a first attempt at some organized presentation of the history of scientific ideas by arranging for a series of lectures; the course was inaugurated by Dr. Charles Singer last May in a lecture in which Greek science and modern science were compared and contrasted. This autumn much fuller arrangements have been made, and a series of courses of lectures will be given. The field to be covered is wide, ranging from Egyptian science to the most important developments of physical science in the nineteenth century, and from biology to mathematics in the eighteenth century. An introductory public lecture will be given on Thursday, October 7 by Professor Sir William

H. Bragg, F.R.S., and on October 13 Dr. Wolf will begin an introductory course of lectures on general history and development of science; this course will be illustrated by lantern slides, and visits will be made to museums. On October 12 at 5.15 P.M., Dr. Charles Singer will begin a course of twelve lectures on the history of the biological and medical sciences from early times till the eighteenth century. Dr. Singer's intention is to make his course a history of medical science, for down to a certain date the biological sciences are inseparable from medicine; he will omit all discussion of social phenomena and personalities. The history of the biological sciences since the eighteenth century will be dealt with by Professor J. B. Hill, F.R.S., in a course of six lectures, beginning next May.

THE Carnegie Institute of Technology of Pittsburgh is completing the most elaborate coal mining laboratory in America. The laboratory, which will be finished by the opening of the fall term, is located beneath the building of the division of science and engineering of the institute. The equipment comprises a full-sized coal mine—a model mine, except that it yields no coal—a mine locomotive and a full set of coal and metal mine machinery, that has been furnished by manufacturers. In addition to the mining laboratories proper there will be a completely equipped ore-dressing and coal-washing plant. It is purposed to extend the mine, during the practise work of the students, along such a plan that it can be utilized for carrying some of the steam and water pipes of the institute.

UNIVERSITY AND EDUCATIONAL NEWS

FROM October 7 through the 17, the University of Buffalo conducted an intensive campaign among the citizens of the city for a fund of five million dollars, to be used partly for endowment and partly for additional buildings. The "drive" was a complete success, and a total of about $5,500,000 was subscribed. The campaign was conducted in the absence of an educational head, Charles P. Norton, having resigned as chancellor of the university early in the summer. He was elected vice-chancellor in 1905, and chancellor in 1909. In his administration a new site for the university was secured, and the new buildings will be erected on a campus of 150 acres at the city line. A committee of the council is charged with the duty of securing a new chancellor.

DR. WALTER T. TAGGART, for many years professor of organic chemistry at the University of Pennsylvania, has been elected to succeed Dr. Edgar Fahs Smith as Blanchard professor of chemistry at that institution. Dr. Smith resigned as provost and professor of chemistry last June. Professor Taggart is now the head of the chemical department of the university.

DR. EDWARD WYLLYS TAYLOR, professor of neurology in the Harvard Medical School, has been appointed to the James Jackson Putnam professorship.

MISS GLADYS BRYANT (Radcliffe '17), has become demonstrator in general physiology at Rutgers College.

THE department of chemistry of Cooper Union announces the appointment to its staff of William N. Pritchard, formerly with the Calco Company, Boundbrook, N. J., and of Harold Hurst, formerly with the Le Doux Company.

DR. ERNEST ANDERSON, for the past three years professor of Agricultural chemistry in Transvaal University College, Pretoria, has been appointed professor of general chemistry in the University of Nebraska.

J. B. FERGUSON has left the research laboratories of the Western Electric Company, of New York City, to accept an appointment as associate professor of research chemistry at the University of Toronto.

PROFESSOR ALBERT EINSTEIN, of the University of Berlin, has accepted the chair of science in the University of Leiden. He will divide his time between the two institutions.

DISCUSSION AND CORRESPONDENCE

PROFESSOR FIELD'S USE OF THE TERM FOSSIL

In examining copies of Science which accumulated during the vacation just closed, a contribution on the "Use of the Term Fossil" in the number of date June 25 has attracted my attention and challenges criticism.

The definition proposed by Professor Field in this contribution is faulty in that it errs in the time concept. He has committed the popular error of considering "historic" synonymous with the present geological epoch. The remains of an animal or plant may antedate human history (be prehistoric) by many thousands of years without belonging to a past geological epoch.

In constructing a definition of the term fossil, it is difficult to improve upon the essential ideas connoted by the term as used by Dr. Karl Von Zittel in his "Palaeozoologie." According to this authority fossils need not be mineralized, nor the remains of extinct organisms, but must possess a certain antiquity—they must have come down to us from a geological age earlier than the present.

We would propose then as a concise definition of fossil, "Any trace of an organism that lived in a past geological age."

While agreeing that accuracy in scientific definition is an object worth striving to attain, we can not concur with Professor Field in objecting to a use of certain scientific terms in a derived sense—commonly figurative. Language is being constantly enriched by such usage.

The expression "fossil botanist" may be criticized as objectional, because ambiguous, but "fossil ripple marks," "fossil suncracks," "fossil flood plains" (Shimer) are illuminating and apt and are valued contributions to geological phraseology. It is futile to inveigh against such usage or against "literary persons" for coining the terms "fossil poetry" and "fossil statesman." Rather should we rejoice in this evidence that our science is not altogether out of touch with modern life. Whether we approve or not, such expressions have come to stay. Not only new words, but old words with a new meaning content are being constantly introduced into a growing language. Words simply will not stay tied, but as Archbishop Trench put it are, as regards their meanings, "constantly drifting from their moorings." The term fossil, itself, is an illustration in point; also the names of certain fossils, as *belemnite, ammonite* and *nummulite,* which embody original erroneous conceptions as to their nature.

As an illustration of a fossil that as the result of refusing to be straight jacketed has made an important contribution to English we have *mammoth,* from the Tartar word *maimon.* In the space of about one hundred years this word has given us in its adjective use a synonym for *huge* so thoroughly incorporated into our speech that few people recognize its exotic character. It may be of interest to some to learn that the first recorded use of the name of this animal in an adjective sense was in Kentucky. John Filson in describing Big Bone Lick in his History of Kentucky, written in 1784, referred to the animal as *maimon.* Within three years, however, we find Thomas Jefferson and others, also in describing Big Bone Lick, calling the animal *mammoth.* Within twenty-five years from this time we find the word beginning to be used as an adjective in the sense of *very large.* The earliest recorded instance of its use in this sense in in 1812, when in a deed it was applied to a very large saltpeter cave in what is now Edmonson but was then Warren county, Kentucky. That this use of the word had not spread to England by 1818 is evidenced by a passage in the letters of James Flint, who writing to England at that date and referring to this large cave in Kentucky remarks that "they call it *Mammoth Cave,* but why I do not know, for there are no mammoth bones found there." Evidently at that time the use of the word in the sense of *large* was too much of an Americanism to be comprehended by this Englishman.

Arthur M. Miller
University of Kentucky,

GALILEO'S EXPERIMENTS FROM THE TOWER OF PISA

MR. PARTRIDGE'S declaration (SCIENCE, Sept. 17, 1920) that "we do not know exactly what experiment Galileo performed" from the leaning tower of Pisa appears to me too sweeping. In the first place, Vincenzio Viviani, in his life of Galileo, speaks of "repeated experiments" not of one "experiment." A series of trials is what one would expect. It is highly improbable that Galileo would perform an experiment before a university assembly which he had not previously tried out. The historic data are as follows: (1) Viviani tells us that Galileo at the leaning tower of Pisa used "different weights"; (2) Galileo in his "De Motu" (probably written before he left Pisa) speaks of dropping wood and lead from a high tower; (3) In his "Dialogues concerning two new Sciences,"[1] Galileo lets Sagredo say:

> But I, Simplicio, who have made the test can assure you that a cannon ball weighing one or two hundred pounds, or even more, will not reach the ground by as much as a span ahead of a musket ball weighing only half a pound, provided both are dropped from a height of 200 cubits.

Later Salviati says that "the larger (iron ball) outstrips the smaller by two finger-breadths." On the remark of Simplicio that perhaps the result would be different if the fall took place "from some thousands of cubits," Salviati replies:

> If this were what Aristotle meant you would burden him with another error . . . since there is no such sheer height available on earth.

It is true that in the above "Dialogue" Galileo does not give the place of experimentation and does not mention the leaning tower. But what other locality in Pisa would have been as favorable? From the above data it follows that Galileo dropped different weights of a variety of materials and noticed which of them fell faster.

[1] Translation by H. Crew and A. De Salvio, New York, 1914, pp. 62, 65, "First Day."

That Viviani was in a position to speak with authority follows from the fact that soon after Galileo had published his "Dialogue concerning two New Sciences," 1638, Viviani became his pupil and was in close contact with him for three years, receiving instruction which began with the theory of moving bodies. Favaro[2] advances evidence which shows that Galileo and Viviani became quite intimate, Viviani admiring the old sage and Galileo treating the young man as if a son.

FLORIAN CAJORI

UNIVERSITY OF CALIFORNIA

JONATHAN EDWARDS ON MULTIDIMENSIONAL SPACE AND THE MECHANISTIC CONCEPTION OF LIFE

IF the Einstein conception of space is multidimensional and inclusive of the essential conceptions of time and place, then Jonathan Edwards, whom John Fiske characterized as the greatest mind of the Western World, may prove to be the spiritual father of this geometry. Thus wrote Jonathan Edwards:[1]

> Supposing that there are two Particles or Atoms of Matter perfectly equal and alike, which God has placed in different Parts of the Creation. . . . If they are perfectly equal and alike *in themselves*, then they can be distinguished or be distinct only in those Things which are called *Circumstances;* as Place, Time, Rest, Motion, or some other present or past Circumstances or Relations. . . . If God makes two bodies *in themselves* every Way equal and alike, and agreeing perfectly in all other Circumstances and Relations but only *their Place*. then in this only is there any Distinction and Duplicity. The Figure is the same, the Measure is the same, the Solidity and Resistance are the same, and every Thing the same, but only the Place. . . . The Difference of Place, in this (the former) Case,

[2] Antonio Favaro, "Amici e Corrispondenti di Galileo Galilei. XXIX. Vincenzio Viviani." Venezia, pp. 8–19.

[1] "A Careful and Strict Enquiry into the modern prevailing Notions of that Freedom of the Will which is supposed to be essential to Moral Agency, Vertue and Vice, Reward and Punishment, Praise and Blame," 1754, p. 243; "Of God's Placing differently Similar Particles."

proves no more than the Difference of Time does in an (the) other.

Edwards, about to become president of the College of New Jersey, and at this date writing as a missionary to the Indians; "Pastor of the Church in Stockbridge," has in the same chapter, these Princetonian thoughts on evolution suggested by Sir Isaac Newton's "Laws of Motion & Gravitation."

Let us suppose two Bodies moving the same Way, in strait Lines, perfectly parallel one to another; but to be diverted from this Parallel Course, and drawn one from another, as much as might be by the Attraction of an Atom, at the Distance of one of the furthest of the fix'd Stars from the Earth; these Bodies being turned out of the Lines of their parallel Motion, will, by Degrees, get further and further distant, one from the other; and tho' the Distance may be imperceptible for a long Time, yet at Length it may become very great. So the Revolution of a Planet round the Sun being retarded or accelerated, and the Orbit of it's Revolution made greater or less, and more or less elliptical, and so it's Periodical Time longer or shorter, no more than may be by the Influence of the least Atom, might in Length of Time perform a whole Revolution sooner or later than otherwise it would have done; which might make a vast Alteration with Regard to Millions of important Events. So the Influence of the least Particle may, for ought we know, have such Effect on something in the Constitution of some human Body, as to cause another Thought to arise in the Mind at a certain Time, than otherwise would have been; which in Length of Time (yea, and that not very great) might occasion a vast Alteration thro' the whole World of Mankind.

Thus the describer of the Ballooning Spiders. Einstein, Conklin; Behold your King!

J. M. C.

Albany, N. Y.

SCIENTIFIC BOOKS

Heredity and Evolution in Plants. By C. Stuart Gager. Philadelphia, 1920. P. Blakiston's Son and Co. Pp. xiii + 265. Figs. 113.

This very readable book is in part a reprint of certain sections of the author's "Fundamentals of Botany" but with considerable new matter added and much of the old recast. An account of the life history of the fern lays the foundation for a discussion of cell structure and the fundamentals of cell behavior in reproduction and at the critical periods of fertilization and reduction. Then comes a chapter on heredity followed by a consideration of results from experimental studies of Mendel, Johannsen, and others.

Chapters entitled "Evolution," "Darwinism" and "Experimental Evolution" give the views of Lamarck, Darwin, Wallace and de Vries. The statement of the mutation theory of de Vries is excellent but there is nothing to indicate to the reader how difficult it is to distinguish between mutations and the results of segregation in impure species the breeding behavior of which is complicated by the presence of lethal factors. There is no reference to the remarkable genetical complications which are known for *Œnothera* material rendering it among the most interesting and puzzling under investigation although correspondingly less favorable for the demonstration of mutations.

The latter half of the book considers the evolutionary history of the plant kingdom from evidence supplied by comparative morphology and life histories, geographical distribution, and paleobotany. In this section is brought together much scattered information which together with the discussion is likely to prove of particular interest to the general reader not familiar with geographical botany and with the striking contributions of recent years from studies of ancient plant remains.

Bradley M. Davis

University of Michigan

NOTES ON CLIMATOLOGY AND METEOROLOGY

AEROLOGICAL WORK IN THE UNITED STATES

Meteorology, until recent years, has been largely a two-dimensional science. Indeed, so strongly has the conception become rooted in the minds of meteorologists, that now, when

the data from soundings of the upper air are becoming available in fairly large quantity, it is necessary to engage in a careful study to determine the most profitable and intelligent way to use them. In recent years, aerological work has been steadily advancing to its place in the forefront of meteorological endeavor, and to-day most national meteorological services have established, or are establishing, aerological divisions. In other words, it is realized that probably the real controls of surface weather lie somewhere in the upper air.

The first aerological work in the United States was done at Blue Hill Observatory, near Boston, under the directorship of Rotch. In 1907, the United States Weather Bureau established a station at Mt. Weather, Virginia. That station, which has a record of frequent kite flights and aerial soundings by captive balloons, was discontinued after seven years. Other stations have been established, however, at Drexel, Nebraska; Ellendale, North Dakota; Broken Arrow, Oklahoma; Groesbeck, Texas; Royal Center, Indiana; and Leesburg, Georgia. The data from the many thousands of kite flights made at these stations have been and are being published in the *Supplements* of the *Monthly Weather Review*. These data include temperatures, pressures, moisture content, wind speed and direction, at various levels in the free-air. It should be said, however, that one of the inherent features of kite data is that they represent conditions in moderate winds only, since kites can not be flown in very light or very strong winds.

A convenient summary of the work of the Drexel Aerological Station was recently published in the *Monthly Weather Review*.[1] The purpose of the summary, says Mr. Gregg, is "to present in brief and convenient form for the information and use of artillery and aviation services the results of free-air observations that have been secured by means of kites at Drexel, Nebraska." There are many tables and charts. The values obtained are the means of 1,074 kite flights. The author, in his synopsis, says:

> A discussion of the reliability of the data indicates that instrumental and observational errors have been largely eliminated; that the monthly distribution is good; that the diurnal distribution is less satisfactory, but probably fairly representative, at any rate for all levels a short distance above the surface; but that, owing to the shortness of the period under consideration and its wide departures at times from normal conditions, some of the monthly means can not be considered as normal values. These irregularities largely disappear, however, in the seasonal and annual averages; and the latter, especially, may be accepted as closely approximating true conditions.

Now that a number of years' data have accumulated, what are the benefits which may accrue from a study of them? Among others, there are two problems, which may be considered: one is of immediate importance, the other is an old one, long recognized, but attacked only at rare intervals, and with varying success. The first concerns itself with forecasting for aviation, the second with the reduction of pressure in the Plateau region of western United States. They represent only two of the many problems, the solution of which aerological data may aid.

A paper on the question of making pressure maps for stated levels in the free-air as aids in forecasting winds aloft for the use of aviation and as a suggested panacea for the long-recognized reduction difficulties in western United States, has just appeared.[2] The central idea about which the work is built is that the Laplacian hypsometric formula requires a value to be substituted for the term representing the mean temperature of the air column which exactly satisfies its definition. Reductions to sea-level obviously can not do

[1] Gregg, Willis Ray, "Average free-air conditions as observed by means of kites at Drexel Aerological Station, Nebr., during the period November, 1915 to December, 1918, inclusive," *Monthly Weather Review*, January, 1920, pp. 1–11. Reprints may be obtained upon application to the Chief of the Weather Bureau, Washington, D. C.

[2] Meisinger, C. LeRoy, "Preliminary Steps in the Making of Free-air Pressure and Wind Charts," *Monthly Weather Review*, May, 1920, pp. 251–263.

this because sea-level lies, in practically all cases, below the station level, hence *there is no air column*. The temperature argument at present employed in reducing to sea-level is the mean of the current surface temperature and the temperature as recorded at the observation twelve hours before, and this *happens* to do very well except in those regions where the so-called air column is quite long. The obvious solution of this difficulty is the measurement of the mean temperature of a *real* air-column above the station.

The work referred to above embraces over 3,000 kite flights made at Mt. Weather, Drexel, and Ellendale. The mean temperature between the surface and the levels of 1 and 2 kilometers above sea-level have been classified by surface wind directions and by months. These temperatures are not used as they stand, but, to render them comparable, they are each subtracted from the surface temperature, thus giving a series of values showing the difference between the mean temperature of the air column and the surface temperature. After doing this for the three stations it was found that they all show certain characteristics. For example, to quote from the synopsis of the paper:

> It was found, in general, that in winter, with southerly winds, the air column has a higher mean temperature than the surface; that in summer, with northerly winds, the air column has a temperature below that of the surface. These effects are due, primarily, to the seasonal variation of surface temperature. The amplitude of the values was much greater at the inland stations, Ellendale and Drexel, than at Mount Weather, near the coast. Aside from the geographical contrasts, the difference between the surface temperature and that of the air column to a height of 1 or 2 kilometers depends, so far as the surface factor is concerned, mostly on the season; and, so far as the temperatures aloft are involved, upon the wind direction.

A statistical study of the data reveals the fact that pressure can be reduced from the station to levels one or two kilometers above sea-level with a very satisfactory degree of accuracy. Indeed, in reducing through an air-column 2,000 meters in length, it is found that the probable error of the temperature determination is so small that, when translated into terms of pressure at the upper level, it amounts to only ± 1.3 mb. For the 1 kilometer level it is only $\pm 0{:}5$ mb.[3]

When this study is carried further, as is contemplated, all kite stations will be discussed and an endeavor will be made to work the scheme out with such simplicity that the observer can know the mean temperature of the air column from the direction of the surface wind, substitute this in his reduction formula and obtain the pressure at the upper level.

The advantages of such charts must be proved by experience. But it is obvious that if they can be constructed accurately, they must yield a far better basis for forecasting winds aloft than do the present sea-level maps —for it is in the very nature of the gradient, or geostrophic, wind to obey the pressure distribution *at its level*. The gradients on the sea-level map can not be of great assistance, even to the height of 500 meters above sea-level. If such charts are thus productive of greater accuracy in forecasting winds in the upper air, their existence is quite justified; and if, in the Plateau of western United States, we can free our weather maps of the barometric apparitions which haunt them at present, it is possible that these charts of the upper air may be of direct value in general forecasting.

The third paper to be mentioned is a short note by Mr. Gregg[4] on the program of aerological work instituted by the Weather Bureau for the hurricane season. It is believed that there is a relation between the velocity of motion of tropical hurricanes and the winds aloft. To collect data, pilot balloon stations have been placed at San Juan, P. R., and Key West, Fla. These, cooperating with the regular permanent pilot balloon stations in

[3] 1,000 millibars is equivalent to a pressure indicated by 750.1 millimeters, or 29.53 inches, of mercury.

[4] Gregg, W. R., "Aerological Observations in the West Indies," *Monthly Weather Review*, May, 1920, p. 264.

the Gulf States and the two Navy stations at Colon and Santo Domingo, will form a "network which, it is believed, will furnish information of great value in the study of these destructive storms and in forecasting their direction and rate of movement." Whether or not hurricanes occur, observations will be made twice daily and the data on trades, antitrades, etc., will well repay the effort, for very little is known of the winds aloft in those regions. If funds permit, this program will be extended during the next several years.

Not only is it essential that means be provided for the extension of pilot balloon work in the West Indies, but also in the United States proper. At present there are about two dozen stations sending daily reports of free-air wind conditions to the forecast centers of the Weather Bureau. This information forms the basis of forecasts that are issued for the information of aviators in the Aerial Mail Service and the Army and Navy Air Services. At least fifty, and preferably a hundred, additional stations are needed. It would be possible, with such a net-work, to construct upper-air wind charts from which accurate and detailed forecasts could be made. It is to be hoped that Congress will see the importance of providing this additional equipment, for its installation would find a direct and immediate reflection in the increased safety of aviation, and in the increased efficiency of our aerial services.

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SPECIAL ARTICLES

NOTE ON EINSTEIN'S THEORY OF GRAVITATION AND LIGHT

THIS paper contains a statement of some apparently unnoticed results dealing with light rays and orbits in Einstein's general theory of gravitation. The full proofs will be published in the mathematical journals.

We recall briefly that Einstein, in his general relativity theory, introduces ten potential functions g_{ik} (in contrast with the single function appearing in the Newtonian theory); these are the coefficients in the fundamental quadratic form

$$ds^2 = \Sigma g_{ik} dx_i dx_k,$$

which defines the four-dimensional space-time world $(x_1 x_2 x_3 x_4)$. When there is no actual gravitation the manifold can be written in the euclidean form $dx_1^2 + dx_2^2 + dx_3^2 + dx_4^2$, or $dx^2 + dy^2 + dz^2 - dt^2$ in the usual coordinates. The path of a free particle is then straight, and so is the path of a light pulse.

In the general gravitational case, the ten potentials obey (in space not occupied by matter) a certain set of ten differential equations of the second order $R_{ik} = 0$, where the left-hand members are the components of what is known in the literature as "the contracted Riemann-Christoffel curvature tensor" (Why not call it simply the Einstein tensor?). A free particle then describes a geodesic, or path of minimum length s. Light rays are found by adjoining the condition that ds vanishes. When the quadratic form is put equal to zero, the result will be described as the *light equation*.

I. Our first result is that if an Einstein manifold has straight geodesics it is necessarily euclidean. This means that if, in an unknown field with vanishing Einstein tensor, coordinates can be introduced such that the paths of all particles are expressible by linear equations, then the field is free from gravitation. It is to be noted that curved four-dimensional manifolds with linear geodesics exist: but our result shows that they do not obey Einstein's equations.

II. An analogous result holds for light rays. If in an unknown Einstein field four coordinates can be introduced so that the light equation takes the usual form $dx^2 + dy^2 + dz^2 - dt^2 = 0$, then there is no gravitation (that is, the manifold is euclidean). This requires proof since an arbitrary function may be introduced as factor in the first member without changing the light equation, although this in general changes the field and the geodesics.

III. We pass now to general manifolds where the paths can not be regarded as

straight lines, so that an actual gravitational field exists. We show that the totality of curved paths completely determines the field. Two Einstein fields which are essentially distinct can never have the same paths. In particular, the paths completely determine the behavior of light.

IV. Our final theorem is that the light equation determines uniquely the gravitational field. In particular, the paths of particles can be predicted from the behavior of light in the field.

It follows that the gravitational field produced by the sun can be explored *either* by observations on the orbits of the planets *or* by observations on the deflection of light rays. *It is not necessary to use both sets of observations.* There is, in particular, a connection between the deflection of light (1.7″ at the sun's limb) and the motion of the perihelion of Mercury (43″ per century): either could have been *theoretically* predicted from the other—but in this fairyland who can lay down a boundary between theory and practise?

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THE AMERICAN CHEMICAL SOCIETY.

(*Concluded*)

Some proteins from the Georgia velvet bean, Stizolobium Deeringianum: C. O. Johns and H. C. Waterman. The Georgia velvet bean contains 23.6 per cent. of protein (N × 6.25). Salt solutions of optimum concentrations (3 per cent.) extract about 15 per cent. of protein. From such solutions 2 globulins, designated the α- and β-globulins, and an albumin may be separated, the 2 former by fractionation with ammonium sulfate and the latter by coagulation from extracts from which the globulins have been precipitated by prolonged dialysis. The proteins are sharply distinguished by their different sulfur- and nitrogen-content, by differences in the percentages of the basic amino-acids as determined by Van Slyke's method, and by the fact that the *β-globulin* does not give the Hopkins reaction for *tryptophane.* The latter observation is of particular interest inasmuch as this amino-acid has been found in all seed globulins heretofore tested. The α-globulin and the albumin from the Georgia velvet bean both contain tryptophane.

The deficiency of cystine in proteins of the genus phaseolus: C. O. Johns and A. J. Finks. Nutrition experiments with the proteins of the navy bean, *Phaseolus vulgaris,* lima bean, *Phaseolus lunatus,* and adsuki bean, *Phaseolus angularis,* show that they are deficient in cystine. This amino-acid must be added before they are adequate for normal growth. The proteins of the navy and lima beans must be cooked as well as supplemented with cystine before they are available. Similar experiments are in progress with the mung bean, *Phaseolus aureus.*

Studies on Neoarsphenamines: P. A. Kober. It was shown in a previous paper that arsphenamine made by Ehrlich's method contains methylalcohol. It is now shown that neo- and sodium arsphenamines made heretofore contain about 30–40 per cent. impurities, consisting chiefly of methyl alcohol, ethyl alcohol, sulphites and ether. Methods were described for the first time, for making sodium arsphenamine, neo-arsphenamine and a soluble mono-hydrochloride of arsphenamine base, which are chemically pure and whose arsenic and sulfur content is close to that required by the theory. Another method was described for making the dihydrochloride of arsphenamine base.

The colorimetric estimation of tyrosine by the method of Folin and Denis: Ross Aiken Gortner and George E. Holm. As the result of a study of the various factors influencing the color intensity of protein hydrolysates to which have been added the phenol reagent of Folin and Denis, according to their directions for the quantitative estimation of tyrosine, we are forced to conclude that: (1) Tyrosine can not be quantitatively estimated in a protein hydrolysate by the use of the phenol reagent because (2) Tryptophane, if present, will also produce intense colors with the reagent, the color produced by one milligram being approximately 85 per cent. of that produced by tyrosine at an equivalent concentration. (3) Indole and indole derivatives, contrary to the statement of Folin and Denis, react strongly with the phenol reagent to produce the blue color. (4) Ferrous iron, and apparently any other easily oxidizable material, also reacts with the reagent. (5) There is considerable evidence that tyrosine and tryptophane are not the only protein constituents which produce blue colors with the phenol reagent. (6) The amount of color which is developed in a solution is not a linear function of the concentration of the reactive material, but the color values fall off

sharply as concentration increases until only an insignificant fraction of the reactive material is indicated by a measurement of the color values of the solutions containing any considerable amount of the reactive substance. (7) Because of the peculiar form of the color curves in relation to concentration, it becomes necessary for one to know the approximate concentration of reactive material in advance of the colorimetric determination so that the colors may be developed and read at such a concentration that the maximum color values will be developed. (8) Because of the fact that solutions of tyrosine and tryptophane do not give the same color values at equivalent concentrations, it is impossible to measure accurately the sum of these amino acids in a mixture which contains no other reactive substances. (9) Protein hydrolysates must not be boneblacked if they are to be used subsequently for a quantitative determination of amino acid content, for the boneblack adsorbs at least tyrosine, tryptophane and tryptophane decomposition products in appreciable amounts. Whether or not other amino acids were adsorbed was not determined. (10) Boneblack contains some easily oxidizable material, probably reduced iron; which dissolves in acid solutions. These acid solutions give the blue color with the phenol reagent.

The humin formed by the acid hydrolysis of proteins. VI. The effect of acid hydrolysis upon tryptophane: GEORGE E. HOLM and ROSS AIKEN GORTNER. Tryptophane was boiled with 20 per cent. hydrochloric acid for various lengths of time up to 144 hours and the solutions studied with respect to deaminization, humin formation and nitrogen distribution. The following conclusions were drawn: (1) Tryptophane is slowly altered and parts of the molecule are broken down by long acid hydrolysis. (2) Tryptophane, in the absence of aldehydes or other reactive compounds, contributes but an insignificant fraction of its nitrogen to the "acid insoluble" humin. A much larger amount of the tryptophane appears in the "soluble humin" after 144 hours' boiling with acid. Since, however, a normal protein hydrolysis rarely requires more than 24 hours' boiling, it appears extremely improbable that the "total" humin of such a hydrolysate is derived from tryptophane without the intervention of some other reactive compound, which we have postulated in our earlier papers to be of the nature of an aldehyde. (3) Tryptophane is relatively easily deaminized by boiling with 20 per cent. hydrochloric acid. probably some of the ammonia of a normal protein hydrolysate is derived from tryptophane instead of being entirely derived from amide groupings. (4) When tryptophane has been boiled with 20 per cent. hydrochloric acid the distribution of the nitrogen is such that errors may be introduced into both the "basic" nitrogen and the "non-basic nitrogen" fraction of a Van Slyke determination.

The alkali reserve in pellagra: M. X. SULLIVAN and R.-E. STANTON. Of fifty-six separate cases tested by alkali reserve by the alveolar air method and by the determination of the carbon dixide bound by the blood plasma, none showed a marked depletion of the alkali reserve, about one third showed a slightly subnormal level, while the greater number of cases were within normal limits. There is little acidosis in pellagra.

The mosaic disease of spinach as characterized by its nitrogen constituents: S. L. JODIDI, S. C. MOULTON, K. S. MARKLEY. Spinach plants, especially their tops, affected with mosaic disease, have a smaller percentage of total, nitrate, acid amide, mono and diamono nitrogen, but a somewhat larger percentage of ammonia than normal plants, nitrous acid being present in diseased plants only. This is due to the fact that denitrification takes place whereby nitrates are reduced to nitrites which reacting on the various nitrogenous compounds present in the spinach bring about elimination of nitrogen in a free state, involving also a loss of nitrogen in the form of ammonia. Very little denitrification, if any, takes place in the roots of diseased spinach. This is evident from the fact that the differences in total, nitrate, amino nitrogen content, etc., of the roots of healthy and diseased plants are usually quite small, running sometimes in opposite direction. Conditions with regard to peptide and protein nitrogen are apparently somewhat more complicated. In the samples examined the proportion of peptide nitrogen is higher in diseased tops than in normal, while the proportion of protein nitrogen is higher in diseased roots than in normal, this being also true of diseased leaves when related to the total nitrogen. This is conceivable since the latter is here *smaller* due to loss through denitrification. In round figures the spinach nitrogen is made up of 55 per cent. protein nitrogen, 4.5 per cent. diamino nitrogen, 5.5 per cent. monoamino nitrogen, and 6 per cent. peptide nitrogen. This means that over 70 per cent. of the nitrogenous compounds occurring in spinach have direct nutritive value.

The effect of conditions on the relation of seed plants to H-ion concentration of nutrient solutions: B. M. Duggar. The results of work previously reported indicate that in the preparation of salt (or so-called mineral nutrient) solutions for the solution culture of seed plants under the most favorable conditions, consideration must be given to the hydrogen ion concentration as well as to salt proportions. The hydrogen ion concentrations of carefully prepared and analytically pure monobasic phosphates are for some plants near or above the critical point for growth maintenance. The effects of changes in the environment, especially temperature and humidity affect in no simple manner the response of the plant to changes in P_H. The optimum P_H like the optimum temperature may be represented by a considerable range of values and may be defined closely only in relation to other environmental conditions.

The relation of dextrose to hydrogen ion concentration with B. Coli: William H. Chambers. By correlating the property of *B. coli* to produce acid from dextrose with the property of alkali formation in dextrose-free bouillon, it was possible to control the hydrogen ion concentration of a growing culture within a narrow zone by the addition of small amounts of dextrose at frequent intervals. The initial amount of dextrose furnished determined the maximum hydrogen ion concentration attained. Reversion of reaction is demonstrated in bouillon with .3 per cent. or less of dextrose. Growth curves plotted from plate determinations show the inhibitory and lethal effects of alkali and acid.

The determination of small amounts of chlorine in tissues: Richard D. Bell and E. A. Doisy. A method, based on that of Neumann, is described for the rapid determination of 3–10 mg. of chlorine in tissues. The tissue is digested with sulfuric acid and persulfate and the gases absorbed in alkali. No cyanide is formed by this digestion process. The sulfur dioxide evolved reduces hypo-chlorite to chloride. The chlorides are precipitated with standard silver nitrate. The mixture is concentrated to a small volume, made up to 25 c.c. and filtered. The filtrate is titrated using the solutions of McLean and Van Slyke. For whole blood and plasma, the results agree with those obtained by Foster's modification of the method of McLean and Van Slyke.

Pectin studies; I. Effect of pectin on the hydrogen ion concentration of acid and of alkaline solutions: H. E. Patten and T. O. Kellems.

The oxidation of acetoacetic acid by hydrogen peroxide in the presence of glucose: P. A. Schaffer.

Influence of fermentation on the starch content of experimental silage: A. W. Dox and Lester Yoder. A study of experimental corn silage at different stages of fermentation which was normal as regards development of aroma and changes in acidity, alcohol and sugar content, leads to the following conclusions: (1) Changes in total acidity, alcohol and sugar are independent of the starch content of the ensiled corn and of the silage produced from it. (2) The first intermediate products resulting from decomposition of starch are not present in demonstrable quantities. (3) The starch content remains constant throughout the fermentation process. (4) The starch granules remain intact, undergoing no physical change that can be detected by microscopic examination.

Water-soluble B vitamines: II. Are the antineuritic and the growth-promoting vitamines the same? A. D. Emmett and Mabel Stockholm. In previous work in feeding pigeons and young rats the same basal diet as the only source of water-soluble B vitamine, we found that the antineuritic vitamine (pigeons) and the growth-promoting (rats) were not the same. In further studies, carried out on yeast, rats and pigeons, it has been ascertained, by using the Williams quantitative yeast method, that the "vitamine" that stimulates growth in the yeast cell is not antineuritic, as has been claimed, but simply growth-promoting. Further, this "vitamine" apparently has very little if anything to do with the growth of the rat. Therefore, the water-soluble B vitamine appears to be much more complex than many have been led to believe.

Charles L. Parsons,
Secretary

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